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ABSTRACT

Research addressed two questions: (1) Does collaborative problem solving lead to greater learning among children than independent work? and (2) Does children's expertise and that of their partner influence learning? To address these questions, the performance of 5-year-old novice and expert singletons copying a Lego model was compared to that of dyads formed by two novices, two experts, or a novice and an expert. A total of 80 children were administered pre- and post-tests and observed in the building task. Findings indicated that children's perception of their skill level relative to their perception of their partner's skill level appeared to influence their tendency to attempt to control the problem solving process and to negotiate a more equitable distribution of labor, if their partner was dominant. Novices learned more from working with an expert partner than from working individually or with a partner of similar skill. Although novice dyads performed better than singletons during the interactive sessions, improvement did not generalize to scores on a posttest which was administered individually. Expert singletons performed as well as expert dyads, suggesting that once a certain level of task proficiency is attained, collaborative problem solving may not be more conducive to learning than individual work. (RH)

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Expertise as a Moderator of Social Influence on Children's Cognition

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Abstract

This research examined the effects of expertise on the social dynamics and learning accrued from peer collaborative problem solving. Five-year-old novice and expert singletons and dyads composed of two novices, two experts, or a novice and an expert were examined while working on a building task.

Children's perception of their skill level relative to their perception of their partner's skill level appeared to influence their tendency to attempt to control the problem solving process and to negotiate a more equitable distribution of labor if their partner was more dominant. Novices learned more from working with an expert partner than from working individually or with a partner of similar skill. Although novice dyads performed better than singletons during the interactive sessions, this improvement did not generalize to an individual posttest. Expert singletons performed as well as expert dyads. This finding suggests that once a certain level of task proficiency is attained, collaborative problem solving may not be more conducive to learning than individual work. It will be argued that children's expertise influences learning during collaboration not only because partners provide information, opposing viewpoints, and guidance, but also, because it influences the dynamics of interaction, which in turn, influence learning.

Expertise as Moderator of Social Influences

On Young Children's Cognition

Of the many moderators that have been proposed to explain social influences of young children's cognition, expertise has been one that has received much attention, perhaps because it figures prominently in theories of social influences on cognitive development. Although Piaget's (1932) Structural approach, Vygotsky's (1978) Socio-historical approach, and Zimmerman and Rosenthal's (1977) Social Learning approach propose different mechanisms for social influences on children's cognition, they all share the view that children benefit from problem solving interactions with more advanced partners. Experts will be particularly influential if they model task behaviors that are slightly more advanced than those of the novice, thus challenging him/her to participate in increasingly more complex steps of the problem.

In this paper, I will discuss the influence of expertise on the learning accrued from peer collaborative problem solving. Despite numerous investigations of this problem (e.g. Ames & Murray, 1982; Doise & Mugny, 1984; Perret-Clermont, 1980; Rosenthal & Zimmerman, 1972; Skon, Johnson, & Johnson, 1981), the findings have been inconsistent. Consequently, it is not possible to determine conclusively whether children will only learn from interactions with experts or whether on occassion, two novices can co-construct a new, higher level of understanding. In addition, it is yet not clear whether children's expertise constrains their ability to profit from interaction, that is, whether <u>both</u> experts and novices benefit from collaborative problem solving or whether novices are more likely than experts to show progress.

This research addressed two questions. First, does collaborative problem solving lead to greater learning than independent work? Second, does children's expertise and that of their partner influence learning? To address these questions, the performance of five-year-old expert and novice singletons was compared to that of dyads formed by two experts, two novices, or an expert and a novice. Eighty children participated. Ten experts and ten novices were assigned randomly to the alone condition. The remainding 60 children were paired as follows: 20 experts formed the 10 expert dyads, 20 novices formed the 10 novice dyads, and 10 experts and 10 novices formed the mixed ability dyads. The task involved copying a Lego model. After an individual pre-test, children participated in two 15 minute sessions in which they either continued to build by themselves or built with a partner. An individual post-test followed the experimental sessions.

Changes from pre-test to post-test scores provide information about the outcomes of collaborative and independent problem solving. In addition, by examining children's behavior during the interaction, one can gain insights about how the interaction process influenced learning.

As seen in Figure 1, expertise mediated interactive benefits. Novices learned more from working with an expert partner than from working individually or with a partner of similar skill. In contrast, expert singletons performed as well as experts who had worked with another expert or

with a novice. However, because experts' performance, by definition, approached ceiling, their task accuracy may not be a sensitive index of learning. If one assumes that learning also involves fine-tuning skills such that one becomes more efficient (cf. Norman, 1978), building speed can be used to index learning in experts. Analysis of the influence of collaboration on building speed showed that although experts who had worked with another expert built more rapidly (mean advantage = 30 seconds) in the post-test than experts who had worked independently or than experts who had worked with a novice, the difference was not statistically significant. Thus, it is possible that once a certain level of expertise has been reached, collaboration will not be more advantageous than individual work.

The performance of novice dyads did not support the hypothesis that interaction allows novices to co-construct a more advanced understanding. However, this co-construction usually has been found in situations where children exhibit two different, albeit wrong, strategies (e.g. Ames & Murray, 1982). Thus, this hypothesis is evaluated best by examining the performance of the four novice dyads whose members made different errors in the pre-test. Contrary to the co-construction hypothesis, despite having different strategies, these children did not benefit from collaboration. Focusing on the dynamics of interaction provides one clue as to why these children failed to benefit from an interaction with a partner that held a different approach to the task.

Although collaboration can facilitate learning, there is no guarantee than children who are told to work together will actually do so. Many researchers (e.g. Ames & Murray, 1982; Damon, 1983; Perret-Clermont, 1980) ensure that children will collaborate by telling partners that they must agree on the problem solution or by facilitating the discussion and conflict resolution. However, usually children will not have an adult facilitator, and thus, it is important to determine whether when left to their own devices, children will work together. It seems reasonable to propose that collaboration will facilitate problem solving only if both partners work together. To test this proposal, I explored the questions of whether the expertise structure of the dyad influenced the social negotiation of collaboration and if such was the case, whether the outcomes of this social negotiation could be tied reliably to improvements in task proficiency both during and following the interaction.

In the present study, dyads were told at the beginning of the session to work together, but were then allowed to develop their own working style. Because changes in interaction patterns over time are more sensitive measures of children's participation in interaction than a single global rating, each pair's interaction style was rated during each minute of the session, yielding 15 ratings for each dyad. Adapting Bakeman and Adamson's (1984) definitions to the present task, joint behavior was defined as that in which partners actively coordinated their behaviors such that they took turns placing and removing pieces from the same part of the construction, monitored each other's behavior, and discussed steps in the task and issues concerning division of labor. Onlooker behavior was defined as that in which one partner did all the building while the other observed his/her activity. Although both of these interaction styles characterized dyads who were working together, whereas joint behavior signaled a cooperative style, onlooker behavior signaled a dominant style. In contrast, parallel behavior characterized dyads who were not working together. Although partners were building on the same

construction, they built different parts of the building, did not monitor each other's behavior, and did not discuss the task. Because the patterns for the second session resembled those obtained for the end of the first session, I will only discuss the patterns of interaction for the first session.

The results showed that the expertise structure of pairs influenced their interaction styles. Joint interactions predominated in expert dyads, onlooker interactions, where the expert built and the novice observed, predominated in mixed ability dyads, and parallel interactions predominated in novice dyads. Thus, one reason for novice dyads' lack of progress is that they failed to interact, and consequently, instantiated the alone condition more than the collaborative condition of the study. The progress of novices working with experts can now be easily explained: they progressed by closely monitoring the expert, thus acquiring task strategies. However, contrary to Vygotsky's proposal, experts did not attempt to involve the novice in a comfortable, yet challenging, part of the problem solving process. Rather, novices became active onlookers, monitoring the model and trying to offer suggestions to their partners.

It remains to explain why the expertise structure of dyads led to such different patterns of interaction. One hypothesis concerns the demands placed on children's resources by the task. Collaboration can be beneficial because a partner can provide task information. However, working with a partner can also impede problem solving because the child must allocate resources not only to the cognitive demands of the task, but also, to the social demands of the interaction. It is possible that the cognitive demands of the task depleted novice dyads' resources, thus leaving them with few resources to allocate to social negotiation. In contrast, the task demanded less of expert dyads and thus, they were able to orchestrate cooperation. We (Azmitia, Bramel, & Schechter, in progress) are currently exploring this hypothesis by manipulating task difficulty within subjects such that expert, novice, and mixed ability dyads and expert and novice singletons are confronted with moderately difficult and very difficult Lego models.

In addition to hypothesizing that task demands influenced collaborative problem solving, I would like to advance an additional hypothesis, that children's perception of their skill level relative to their partner's skill influenced the negotiation of the distribution of labor during the initial minutes of the session and that the result of this negotiation influenced interaction patterns for the remainder of the session.

Figure 2 shows dyads' patterns of interaction as a function of time, that is, the mean number of joint, onlooker, and parallel interactions exhibited by expert, novice, and mixed ability dyads during the beginning, middle, and end of the session. An analysis of variance indicated that all dyads exhibited a similar number of joint interactions during the beginning of the session, but that only expert dyads continued to work jointly during the middle and end of the session. Trend (linear trend) analyses indicated that over time, mixed ability dyads significantly increased their onlooker behavior and novice dyads significantly increased their parallel interactions.

Changes in the number of joint interactions overs time can be explained, at least in part, by how partners resolved discussions concerning division of labor during the beginning of the session. Although all but one dyad began the task cooperatively, soon one partner attempted to take over the task by

either physically impeding his/her partner's building or by asking the partner to watch him/her build. In the beginning of the session, children tended to challenge their partners dominance, reminding him/her that they were supposed to share or countering the physical impedence by removing the partner's hand from the construction.

Although during the first five minutes of the session there were no differences in the number of discussions concerning the distribution of labor as a function of the expertise structure of the dyad, each type of dyad resolved them differently. Members of expert dyads generally persisted in the negotiation until their partner agreed to take turns building, thus retaining their joint interaction style. Although novice dyads also attempted to reinstate joint behavior, they did not persist if their first negotiation attempt failed, usually deciding to work independently, thus increasing their parallel interactions over time. It is possible that the task demands did not allow novice dyads to spare the resources needed for social negotiation. Alternatively, it is possible that partners had become aware of each other's skill and knew that each had little to offer. Because collaboration did not have an obvious advantage, partners decided to work independently. Finally, the experts from mixed ability dyads resisted their partners' attempts to participate in the task and usually were able to convince them to become onlookers by citing their better building skills or, in a few ocassions, by promising to allow them to place the last piece on the construction. Again, it appears that children had become aware of each others' expertise and thus, were on the one hand unwilling to relinquish control to a poor builder and on the other, willing to allow a better builder to complete the task.

In conclusion, expertise influences both the cognitive and social aspects of peer collaborative problem solving. These data add to the literature that has suggested that working with a more expert partner is more conducive to learning than working with a partner of similar skill. In addition, it appears that dyads' interaction styles contribute to the cognitive outcome of collaboration and that interaction style is influenced by the expertise of the participants. Children's perception of their skill relative to their partner's will influence their resolution of discussions concerning the division of labor. In turn, this resolution will influence partner's involvement in the remainder of the interaction. Because collaborative problem solving will benefit learning only to the degree that partners participate in the interaction, the patterns of participation observed in this study provide additional information as to why collaboration with an expert can be more beneficial than collaboration with a novice when no measures are taken to ensure that children will work together.

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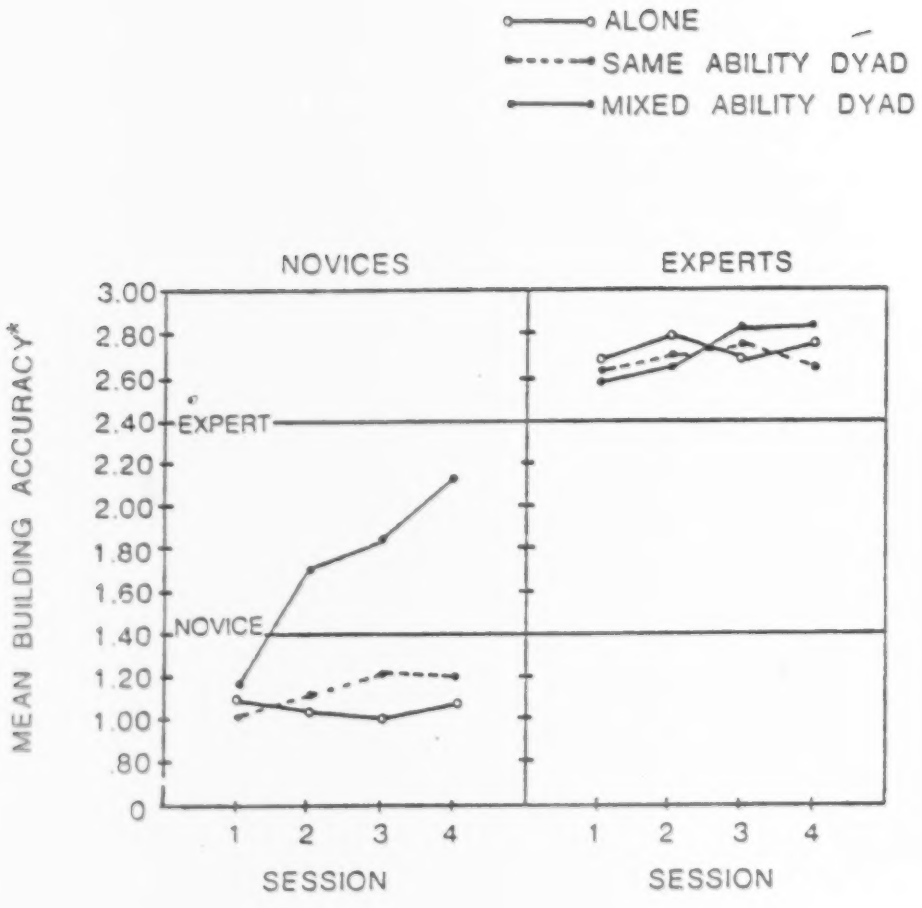
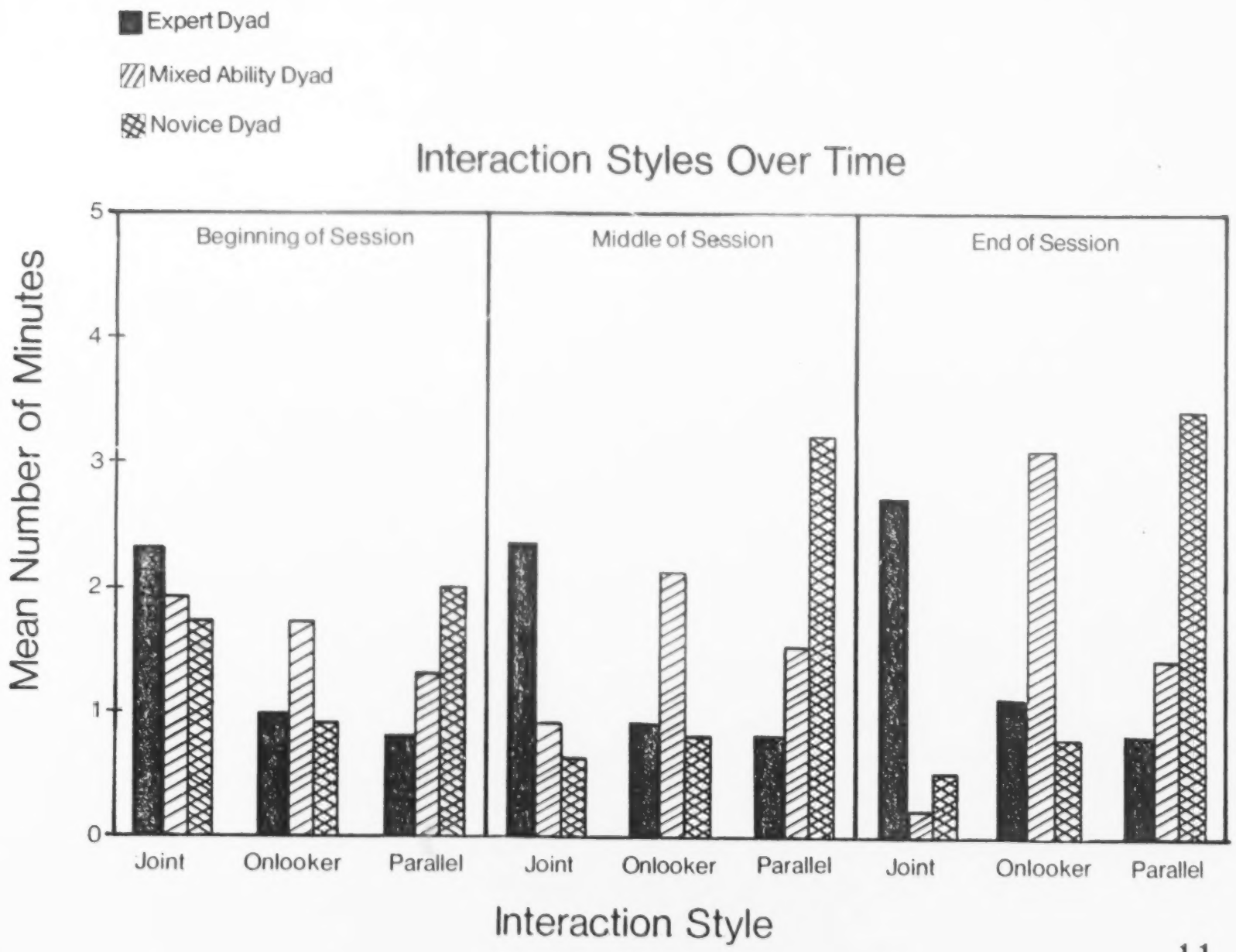
Figure 1



* SCORING: A placement or removal was judged according to accuracy of location, color, and size. Thus, a mean score of 3.00 represents 100% accuracy for all placements.

Figure 2


Expert Dyad
Mixed Ability Dyad
Novice Dyad
Interaction Styles Over Time
Mean Number of Minutes
0
1
2
3
4
5
Beginning of Session
Middle of Session
End of Session
Joint
Onlooker
Parallel
Joint
Onlooker
Parallel
Joint
Onlooker
Parallel
Interaction Style